ECONOMICS OF THE UTILIZATION OF COMMERCIAL TIMBERLAND ON LIVESTOCK RANCHES IN NORTHWESTERN CALIFORNIA

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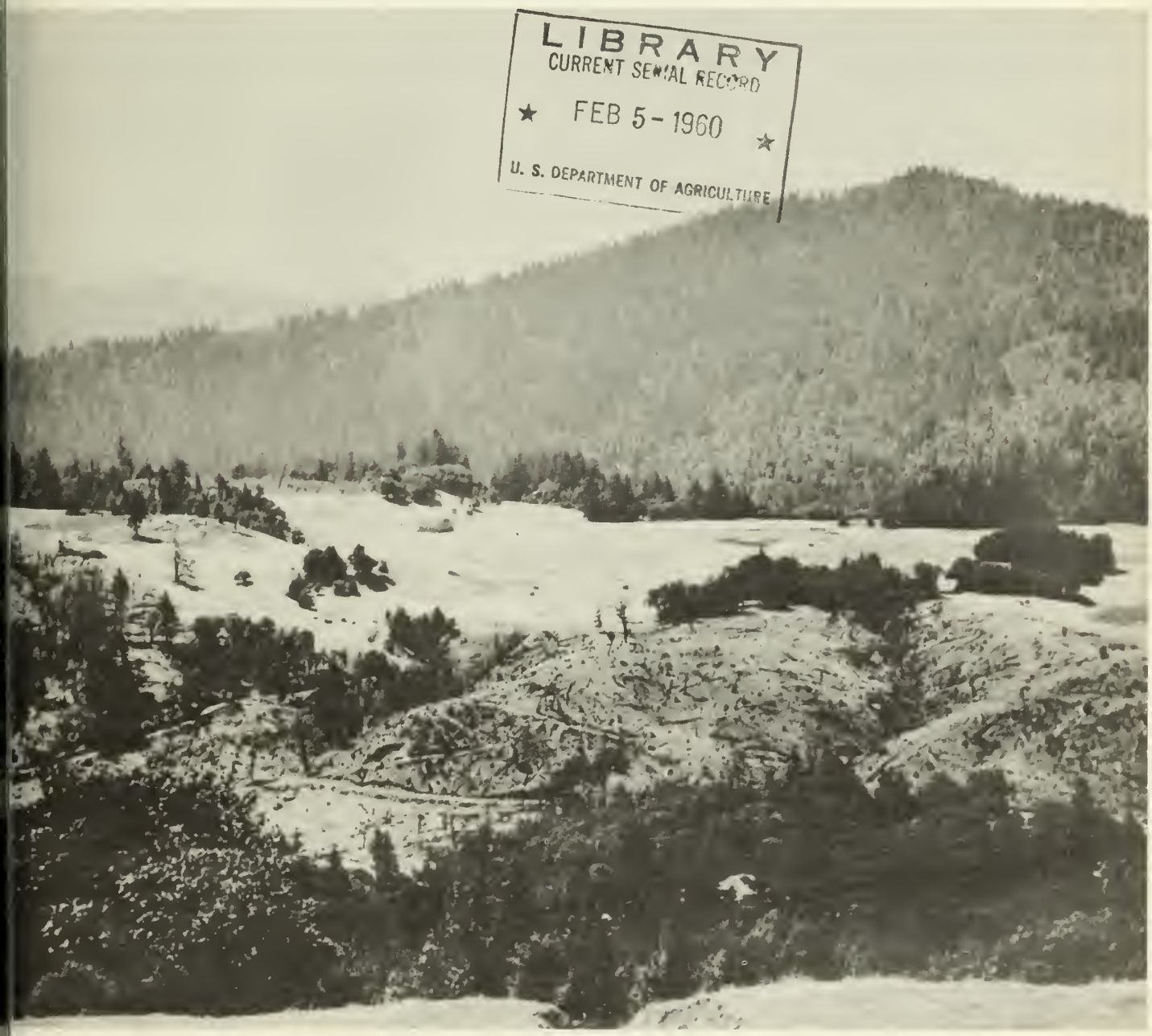

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IN BRIEF

Ranchers in northwestern California face a difficult economic decision. Should they clear-cut their Douglas-fir timberlands and convert them to grass? Or should they manage the land for timber production? To gather information that will help in making this decision was the purpose of this study. Here are the highlights of what we learned:

On suitable terrain and exposures, timber soils can be converted to grassland. The conversion process, however, is difficult and requires careful range management for many years. Ranchers spend about $26 to convert an acre of timberland to grassland. But the present economic limit for this is about $20. The upper limit on total investment per acre of converted land, including cost of cutover land, is about $30.

If these soils remain in timber production, planting may be necessary to assure suitable reproduction of Douglas-fir timber. Natural regeneration alone will not always do the job. About $50 is the maximum that can profitably be spent in restocking an acre of medium quality (site III) timberland. Because of potentially higher yields, more can be spent on good land (sites I and II).

In the long run, good quality timberland will yield more if left in timber than if converted to grassland. The breaking point in economic benefits from timber or grass is on site III land. With a southern or western exposure, this land yields more when it is in grass. With a northern or eastern exposure, it probably yields more when in timber.

THE SITUATION

Lumbering is the major industry in northwestern California. Today, after a little more than a century of activity, this industry has grown from a few waterpowered sawmills to several hundred modern sawmills of many types and sizes and capable of producing billions of board-feet of lumber annually. About half of the population of the study area is dependent--directly or indirectly--on the timber industry. Humboldt and Mendocino Counties, which make up the major part of this forest area, are the leading timber-producing counties of California.

Because of the importance of the timber industry to the economy of the area, local groups are working to keep commercial forest land in timber production so that it will contribute the raw material necessary to maintain the existing lumber and other wood-using industries (7).[1/] The forests are also recognized as a valuable asset of industries serving recreationists.

Livestock ranching is the second important segment of the area's economy. Along the coast and interspersed among the timbered areas are large tracts of natural grassland. They provide valuable range feed for sheep and cattle. Most of this rangeland is in 1,000-acre to 20,000-acre ranches. Some contain sizable acreages of commercial forest land. Most of this timberland was originally acquired not to grow timber, but to establish efficient ranch units along with the grass and woodland grass with which it was intermingled. Smaller acreages were also obtained from former timber operators as cutover land. The ranchers usually own enough acreage to range their sheep and cattle all year long with some supplementary feed during late fall and winter in years when local feed and forage conditions are poor.

Ownership of rangeland, particularly in the north, has been relatively stable. Livestock ranches were established when the land was originally patented by the first settlers. Many descendants of these first settlers still occupy the original ranch holdings, although some of the holdings have been altered through acquisition and sale of certain lands.

1/ Underlined numbers in parentheses refer to Literature Cited.

Figure 1.- Typical grazing scene on cleared cutover timberland in Humboldt County, California.

Because of the low turnover, it is difficult for ranchers to acquire additional rangeland, and the few ranches occasionally offered for sale command high prices. Consequently, ranchers have only limited opportunity to expand their range operations by buying or renting additional natural grasslands. As an alternative, they try to expand their range areas by clearing and seeding timberland on their present holdings after the timber has been sold and cut.

Ranch holdings contain about a third of the privately owned commercial forest land in northwestern California (8, p.46; 9, p. 54). This farm-forest land represents an important segment of the timber resource, and its management will have considerable effect on the economy of this region.

In the past, the owners of forest land in ranch holdings have been interested primarily in raising sheep and cattle. Few of them considered regrowing the timber once the old-growth trees were logged. The general practice was to burn the cutover land and try to convert to grass or to let the cutover land stand idle.

Most of the commercial timber on the ranches is Douglas-fir--a species which until comparatively recent years had little or no commercial value in this area. For a long time, ranchers considered Douglas-fir trees a liability. They had to spend time, effort, and money to slash and burn the trees to get more grazing from their land. Few ranchers could foresee the day when their trees would become an asset they could convert to cash.

During and after World War II, increased demand for construction lumber stimulated the demand for Douglas-fir timber. At first, ranchers welcomed the opportunity to dispose of their timber at prices that paid only the cost of clearing the land for grazing. Later, as Douglas-fir timber prices rose to levels that brought substantial incomes, ranchers began to question the wisdom of cutting the timber and converting the land to grass without first considering production of timber as an alternative use. Others wondered what the overall effect of reduction in timber-producing acreage would be on the economy of a region whose major industries depend chiefly on timber as a natural resource (16, p. 30).

This report deals with the first question--the economics of alternative uses of commercial timberland on ranch holdings when the old-growth timber is cut. It is designed to provide information that will help ranchers decide whether it will be more profitable for them to restock their cutover land with timber or to clear and seed it to grass as many have done in the past.

The information comes largely from personal interviews with ranchers who have cleared commercial timberland in different parts of northwestern California, and from on-the-ground examinations of the cleared areas to determine the grazing yields produced by different land clearing and seeding practices.

CLEARING TIMBERLAND FOR GRAZING

Clearing operations on commercial timberland have been going on in this area for many years. Some clearings were found that had been started in the 1890's. These old clearings have held up remarkably well. In appearance and grazing capacity they compare favorably with adjacent natural grassland areas. They were developed by hard-working old timers who spent much time and effort slashing and burning the timber, gathering native grass seed, and sowing the seed on the burned-over land. In time and with proper grazing management, the woody vegetation disappeared and the grass cover became permanent.

Although old clearings now look like natural grassland areas, soil analysis and historical evidence indicate that they once supported timber. Their existence proves that certain kinds of timberland can be converted to grassland, provided the

Figure 2.- A 50-year old clearing on Josephine timber soil. This land once grew a dense stand of Douglas-fir, tanoak, madrone, and other associated hardwoods. It was converted to a grass cover by use of fire, goats, and sheep.

operator knows how to do it and is willing to work hard at it. All of the ranchers who have succeeded in clearing land admit it is no easy task and certainly not one for amateurs. It takes plenty of work and experience to do a successful job. These men recognize that in converting timberland to grassland they are working against a natural succession of plant growth and that consequently they must put extra effort into the clearing job in order to succeed.

In the old days clearing was done entirely by hand methods, chiefly with saw and axe. According to old-time ranchers, burning was easier and less costly because there were fewer people living in the area, less logging activity, and consequently less slash in the woods. The fires were not so likely to get out of hand and cause serious damage. The fire-control problem was less complicated also, and ranchers could burn large areas during years when weather was favorable. Seeding was by hand and some ranchers produced their own seed from native grasses.

Slashing timber with hand tools required from 2 to 4 man-days per acre, depending upon the density and size of the trees and the amount of brush on the land. Douglas-fir trees, some 2 to 5 feet in diameter, had little or no market and had to be felled and destroyed. There was some demand for tanoak bark, which was often peeled before the slashing was done. Despite the relatively low prices for labor and materials, even then slashing, burning, and seeding cost from $10 to $15 per acre for a good clearing job.

Later on, power tools made land clearing easier. Power chain saws, heavy-duty bulldozers, and seeding by airplane made possible the slashing, burning, and seeding of large areas of timberland more quickly and efficiently. But the costs of clearing unlogged timberland remained high--close to $20 per acre in the late 1930's and early 1940's.

After about the middle 1940's, ranchers began receiving money for cutting trees which they formerly paid to have slashed. The market for Douglas-fir timber returned a profit for unwanted trees and helped to finance clearing and seeding. Slashing the trees that remained after logging cost ranchers from $6 to $18 per acre in time or money against $40 to $50 for slashing unlogged land. Slashing, preparing firebreaks, burning, and seeding cutover land at prices prevailing in the early 1950's cost from $9 to $30 per acre.

Then too, changes in the timber industry stimulated cutting on the ranches. Thirty years ago and earlier,

operations were conducted chiefly by the major lumber companies that owned and operated large stationary steam-driven sawmills. These sawmills were generally located at strategic points on or near the coast, and the timber was fed to them primarily by logging railroads built especially for that purpose. A rancher who had timber could sell it only when his land happened to be on or near the railroads and his cutting schedule happened to coincide with that of the lumber company. As there was limited demand for the kind of timber usually found on the ranches, the ranchers' chances for selling timber from their holdings were poor.

After about 1940, when the lumber market began to recover from the depression of the 1930's, timber operators began to come into northwestern California from Oregon and Washington. These operators came to buy readily available timber on ranches and other small private holdings, and they introduced a new type of timber operation. They built smaller mills in small inland communities and set up portable mills on ranches and trucked lumber to various marketing centers. Tractor logging and heavy-duty trucks replaced the much more expensive high-lead skidding equipment and railroads and made possible logging operations on a smaller scale with less capital outlay. At the same time the demand for livestock products increased and prices were more favorable. This development favored clearing the cutover land for livestock grazing without much consideration to timber restocking.

In general, the demand for Douglas-fir timber has continued to be good, but the demand for and the prices of livestock products have declined since 1951 (12, pp. 309, 335), and recently some ranchers have derived a substantial share of their income from sale of timber. In the long run, the outlook appears to be more optimistic for industrial wood, which includes Douglas-fir timber, than for certain livestock products, especially lambs, mutton, and wool--the major livestock items produced from grazing cutover land in northwestern California.

Estimates of potential demand for industrial wood in 1975 show a percentage increase of from 25 to 40 percent over the 1952 demand (13, pp. 25-32). The estimated 1975 demand for sheep and lambs showsan increase of about 16 percent over 1954. However, for cattle and calves, which might be produced instead of sheep and lambs, the long-run demand compares more favorably with that for industrial wood (1, pp. 15-20).

Methods Used in Converting Timberland to Range

Successful conversion of cutover timberland to grass requires several different operations--slashing, burning, seeding, and continuous good management. Slashing--felling the trees left standing after logging--ordinarily is done with a chainsaw on the steeper slopes. On level land, ridgetops, and gentle slopes, a heavy-duty bulldozer may be used effectively for this job.

Once the trees and slash are on the ground, the ranchers prepare fire trails and take other precautionary measures to contain a slash fire.

Slashing and preparing the land for burning usually costs from $6 to $18 per acre. Costs vary with the density and size of the residual trees, topography, the type of equipment used, the size of area, and the experience of the operator. Some ranchers make price concessions in their timber-sale contracts so the loggers will do some of this work as part of their logging operations. A good slashing job is essential to get sufficient fuel on the ground for a clean burn.

After the land has been prepared for the burn, the rancher obtains his permit to burn from the local district office of the California Division of Forestry. A technician from this division then inspects the area to be burned and advises the rancher on certain technical matters concerning the burning operation. This service usually costs the State from $0.10 to $0.50 per acre.

The burning is performed when the weather is most favorable for the job. Selection of the proper time for the burn is critical. If the weather is windy and too dry, the fire is difficult to control and the risk from an escape fire is great. But if the atmosphere and ground are too damp, the chances for a good clean burn are unfavorable and a poor job of clearing usually results. Experienced ranchers try to select a day when wind and moisture conditions are such that a hot enough fire is possible to give a reasonably clean burn with a minimum of danger from an escape fire.

In some sections of northwestern California, ranchers have formed informal groups to help each other in the burning operations. They exchange work and rotate the burning operations from ranch to ranch. This permits burning with a minimum of cash outlay.

Some of the ranchers in these groups become proficient in selecting suitable weather for burning and in controlling the fires. Escaped fires are dangerous to life and property and costly to subdue. As an example, it costs the State Division of Forestry about $0.30 per acre to handle a controlled burn, but suppressing an escaped fire costs $7.00 or more per acre.

For the first burn after logging and slashing, a rancher usually pays $0.30 to $2.00 per acre. The amount depends upon the size of area burned, the kind and amount of slash on the ground, weather, topography of the land, and other related physical factors. Ranchers usually burn areas ranging from 50 to about 300 acres. If handled properly, the larger areas are the most economical to burn, but some ranchers, especially if they are short-handed, prefer to burn a large timberland area in small parcels of from 5 to 10 acres each. They say that they can do a better job by burning a small acreage, can handle the fire easier, and stand less chance of an escape.

The next step is to seed the burned area. This may be done by airplane or by hand. Size of the area, preference of the ranch operator, and availability of aircraft all affect the choice of method. Small areas are usually seeded by hand. Costs depend on methods used, size of area, locality, skill of the operator, rate of seeding and species selected, roughness of terrain, amount of debris remaining on the ground, and other physical characteristics of the area. Excluding the seed, costs range from about $0.70 to $2.50 per acre.

Popular seed mixtures for cleared timberland include perennial and annual rye grasses, orchard grass, and subterranean clover. Mixtures sometimes contain small amounts of seeds of a wide variety of other grasses and clovers to suit the preferences of the individual ranchers.

Seed costs range from $2.00 to $7.50 per acre, depending on the kinds of seeds selected and the quantity used per acre.

Most ranchers sow their seed in the late fall, shortly after burning and before the winter rains arrive. Broadcast seeding does best on sites where the seedbeds have a mellow surface soil layer in which the seed will be buried. It is particularly successful where the fire has produced a layer of white ash which will cover the fallen seed. On seedbeds where the surface remains hard, broadcast sowing is not successful unless it is followed by disking or some other method of covering the seed. If the seeds remain uncovered, drought, frost heaving, runoff from heavy rains, and other hazards are likely to result in the establishment of a poor grass cover.

Figure 3.- Cutover land before clearing operations are started.

.gure 4.- Cutover land that has been partially slashed, burned over once, and seeded to grass.

Figure 5.- Cutover land that has been slashed, burned over 2 or 3 times, and seeded to grass.

Figure 6.- A conversion job that has been completed. Grass has replaced nearly all of the woody vegetation formerly on the land.

After the seeds germinate, some ranchers turn their animals into the area the following spring; others defer grazing for a whole season until the grass plants become well established. Apparently the choice is dictated by the absence or presence of certain sprouting tree and shrub species in the burned areas. Those who graze soon after sowing believe that grazing is necessary to keep back the sprouts. The many succulent young sprouts that appear shortly after a burn provide much browse for the animals. If not grazed, the browse would soon be lost; if left too long without grazing, it would become unpalatable and consequently difficult to control.

Proper management after burning and seeding is important to the success or failure of a clearing job. Ranchers say that the number and kind of animals grazed after burning and seeding affect greatly the type of cover that will grow. A proper balance between animals and area is essential. If the number of animals is too large, overgrazing of the young grass results. If the animals are too few, they do not browse the young sprouts sufficiently to control the hardwoods and other woody species.

Apparently, differences in methods used in clearing land are not as important as the experience and skill of the operator who applies them. Usually, the results of different practices have been about the same.

After a burned and seeded area has been grazed for 3 or 4 years, the ranchers contend that the woody vegetation becomes too large for the livestock to browse effectively. The time is then right for the area to be reburned. The first reburn sometimes requires a certain amount of slashing with chainsaw and bulldozer, and piling of the slash and debris before burning. Fire trails also need to be reopened and cleared for fire-control purposes. A reburn ordinarily costs the rancher from $0.60 to $3.75 per acre, depending on the success of the initial burning job, species present, slope and topography, climate, and other associated physical factors. Reseeding after a reburn is not always necessary because grass seeds often survive a fire.

Converting timberland to grassland is easier if the land is relatively free of hardwood trees and shrubs. Competition from unwanted plants is easier to control, and a good clean grass stand can be established with minimum cost. The density of the vegetative cover to be cleared affects greatly the economic feasibility of a conversion. Slashing and burning heavy stands of hardwoods are costly operations and in many instances the grazing returns do not justify the high costs. But in general, cutover Douglas-fir timberland with little or no hardwood or brush cover offers possibilities for conversion at moderate cost.

Figure 7.- If management of cleared timberland is neglected, woody vegetation will soon reinvade a converted area. This scene shows several woody species starting to take over a converted area.

Figure 8.- A former clearing in the background where reinvasion by woody vegetation is well under way.

In most of the ranches surveyed, browsing animals were used to control the sprouts. In this area, sheep are commonly used, and occasionally goats. The ranchers who used goats were successful in their conversion jobs and accomplished their objectives with fewer reburns than did ranchers who used only sheep. Apparently, there is some question as to how seriously goats compete with sheep in grazing the grass cover. Those ranchers who use goats contend that the goats prefer the sprouts to the grass and therefore do not compete seriously. A large deer population is also helpful in controlling some sprouting species.

Proper timing and intensity of reburns are essential to a good conversion job. Apparently, the hardwood and brush cover must be reburned within 3 or 4 years, before it becomes too large and heavy for a grass fire to scorch it. Sufficient fuel must be on the ground to produce a hot enough fire to kill the sprouts and shrub seedlings. Some otherwise successful conversions have been lost by improper timing of reburns and lack of fuel.

Figure 9.- Grassland conversions are most successful in timber areas near natural clearings, on southern and western exposures and slopes that are not too steep.

Figure 10.- Erosion is often a serious problem on timberland conversions, particularly if the cleared slopes are too steep. Only timberland with moderate slope should be considered for clearing.

Figure 11.- An attempt at clearing cutover land that has not been followed through to completion. Land in this condition has little value for either grazing or timber production because hardwood brush has little or no potential value in this area.

Local ranchers say that the distance of the timberland area from the coast and the elevation influence the conversion process. These factors affect moisture conditions and moisture affects regrowth of the woody vegetation. Conversions are likely to be less costly and more successful in inland areas where drier conditions prevail.

Most ranchers believe that slope exposure is an important element in success. From past experience, they recognize that slopes facing south and west are the easiest and consequently the least costly to convert from timber to grass. These are the hotter, drier slopes.

Northern and eastern slopes are difficult to clear and to maintain in grass. Costs of clearing are high because of the heavy cover of hardwoods and conifers, and the cleared areas tend to revert to hardwoods and brush. These northern and eastern slopes, however, are frequently the best timber sites. They offer opportunity to develop good stands of Douglas-fir if the hardwood and brush cover can be controlled long enough to give the tree reproduction a head start. Experienced ranchers usually do not attempt to clear northern and eastern slopes, particularly if the vegetative cover is dense.

Soil is a major factor in determining the timber- or grass-growing capacities of any area. Some soils are highly productive for timber. Others produce little or no timber but will grow a good grass cover. Soil characteristics important to timber or grass growth are depth, texture, moisture and drainage, acidity or alkalinity, and rockiness. In northwestern California, the better Douglas-fir timber grows on well-drained soils that are more than 3 feet deep, acid in reaction, and of loam or clay loam texture. Deep soils of the Hugo, Josephine, and Melbourne soil series are the most important timber-producing soils in Mendocino and Humboldt Counties--the counties where upland soil surveys have been made. Other soils like the Yorkville, Kneeland, McMahon, and Laughlin series support natural stands of grass and do not support commercial timber stands. These grass areas provide the basis for the extensive range livestock industry of this area.

From observations in the field, it appears that the Josephine and Hugo soils are the timber soils most commonly cleared for grazing. The oldest and cleanest clearings were found on Josephine soil. This fact suggests that Josephine soil may be more susceptible to grassland conversion than other timber soils.

Selection of areas for conversion is simplified by large-scale soil-vegetation maps which are being produced for wildland areas of the State as a cooperative project of the U. S. Forest Service, the California Division of Forestry, and the University of California. The maps show soil series, soil depth, steepness of slope, species composition of existing vegetation, and on timber soil, the timber site class. These guides to quality of timber and grass soils provide the landowner with the means of preparing land-use plans for his property with a minimum of effort (18). Maps are available for the major timber-growing counties (Mendocino and Humboldt) and surveys are underway in other sections of northwestern California.2/

2/ These maps are available from the Regional Forester, U. S. Forest Service, 630 Sansome Street, San Francisco, California.

Costs of Clearing Timberland and Establishing and Maintaining a Productive Grass Cover

Costs of converting timberland to grassland in recent years have averaged about $26 an acre, but the upper and lower limits differ widely (table 1). The costs presented here are estimates of time and money expended by ranchers who actually have done each operation necessary for a successful conversion of cutover timberland. Whether a job will fall near the upper or the lower limit will depend largely on the location, kind of soil, type and density of the vegetative cover, slope exposure, elevation, other associated physical conditions of the land to be treated, and the experience of the operator. For the most part, the individual rancher, who has intimate knowledge of his land, must determine at which end of the scale his costs are likely to be. He can then estimate the costs accordingly.

The costs quoted in table 1 evaluate at standard rates the labor of the operator and his family, and that of his neighbors, which is sometimes donated and represents no actual cash outlay by the ranch owner. Use of mechanical equipment is also charged at standard rates. The rancher who owns his own equipment often performs clearing jobs at slack times when the equipment might otherwise be idle and consequently not chargeable at full value. These factors must be considered in interpreting the cost figures presented here. It is assumed that those who work on the clearing job could obtain alternative employment elsewhere and that consequently the time and effort have specific values chargeable to the job to be performed.

On this basis, conversion will cost from about $10 to $30 per acre, not including the value of the cutover timberland or maintenance costs.[3/] In this area, cutover timberland usually sells for about $10 per acre. The total cost of converted land including the original cost of the cutover land, then, will usually be somewhere between $20 and $40 per acre.

3/ Maintenance costs consist principally of construction and maintenance of fences built to control animal numbers, some hand reseeding of bare spots, and other minor miscellaneous tasks necessary for proper management of the range after the major conversion operations have been performed.

Table 1.- Estimated range of costs per acre of converting cutover timberland to a grass cover, northwestern California, 1956[1/]

Type of operation	Lower limit	Upper limit	Average
	Dollars	Dollars	Dollars
Slashing and land preparation	6.00	18.00	11.00
Burning	0.30	2.00	1.00
Seeding	0.70	2.50	1.15
Grass seed	2.00	7.50	4.20
Total initial cost	9.00	30.00	17.35
Reburns (3 times over)	1.80	[2/]11.25	[2/]9.00
Total cost of conversion	10.80	41.25	26.35

1/ Computed from ranch records for the period 1951-56 and adjusted to 1956 prices.

2/ Includes land preparation before burning.

Value of Cutover Timberland Converted to Rangeland

In northwestern California, roughly from 2 to 5 acres of rangeland (natural range or converted timberland) are required to carry 1 sheep for 1 year; in the usual range-management terms, this is a grazing capacity of 10 to 25 acres per animal-unit year.[4/] The average stocking of 15 ranches examined in this area was about 17 acres per animal-unit year. These figures agree more or less with those presented in a special study made in Mendocino County (4, p. 2) and with opinions of range specialists who have examined and appraised rangeland in the study area.

Rangeland on or near the coast yields more grazing than rangeland farther inland, but an average of 17 acres per animal-unit year appears to fit most of the situations studied here.

4/ An animal-unit year is the quantity of feed required for good growth and production by a mature head of cattle or by 5 mature head of sheep for one year.

Range specialists who have examined the vegetation on both the natural grasslands and on converted timberlands find little difference between the quality of grass produced on the average natural grassland soil (for example, Laughlin soil) and that produced on a converted timber soil (for example, an area of Josephine soil that has been cleared and kept cleared for 10 or more years). The difference in productivity on these 2 soils can be expressed roughly as a ratio of 8 to 10 in favor of the Laughlin soil. This means that it might take 10 acres of converted Josephine soil to equal the grazing value of 8 acres of Laughlin soil.

Assuming that 17 acres per animal-unit year is the average grazing capacity on a converted timberland soil (like Josephine or Hugo), and a commercial rate of $3 per animal-unit month (or $36 per animal-unit year) is a conservative average value for the grass produced, then the gross return per acre on converted timberland would be $2.12 per year.

With taxes estimated at about $0.30 ($5 per acre assessed value with a tax rate of $6 per $100 valuation) and maintenance costs of $0.40 per year, the net return to land will amount to $1.42 an acre. Capitalized at a 5-percent interest rate, the $1.42 net return indicates an average value of $28.40 for 1 acre of converted timberland (table 2).

This figure of about $28 appears to be reasonable because livestock ranches in Humboldt and Mendocino Counties, some of which included converted cutover timberland, recently sold for prices ranging from $25 to $30 per acre.

A few ranchers were found who rented land similar to that studied. Most of the land rented at rates ranging from $1.25 to $1.50 per acre. As the $1.42 estimated net yearly return to land comes within this rental range, the land values presented here appear to be reasonably realistic.

A rancher in this general area who contemplates an extensive conversion of cutover timberland to grassland should estimate carefully the costs involved in doing the job. If he estimates costs of more than $30 per acre, including a $10 value for his cutover land, he should consider alternative methods of obtaining additional feed for his livestock--for example, he might improve the rangeland he already has or develop irrigated pastures--and devote his cutover timberland to some use other than grazing.

Table 2.- Estimated yearly returns per acre at $3 per animal-unit month from timberland converted to grassland with grazing capacities ranging from 9 to 25 acres per animal-unit year

Acres per animal-unit year	Value of animal-unit year	Value of forage	Yearly taxes and maintenance costs	Rental value of converted land	Capitalized value of converted land (5% interest)
			Dollars		
9	36	4.00	0.70	3.30	66.00
13	36	2.77	0.70	2.07	41.40
17	36	2.12	0.70	1.42	28.40
21	36	1.71	0.70	1.01	20.20
25	36	1.44	0.70	.74	14.80

Growing timber is a logical alternative use, but it confronts the rancher with several questions he can seldom answer from personal experience. What methods shall he use and what problems arise in growing timber? What will it cost to reproduce a timber stand on cutover land similar to that ordinarily used for grassland conversion? What is the probable value of restocked cutover timberland to the livestock rancher who chooses to place his land in timber production?

The economics of timber growing differ materially from the economics of livestock and other agricultural production. Timber production is a long-time venture. "Its annual increments cannot be harvested in the year they are produced but must accumulate for many years in any given tree, even when the forest as a whole is managed on a crop-production basis." (17, pp. 49-56.) Nature alone produced most of the timber products cut from the forests of northwestern California. They were not harvested as a crop produced by men. The accumulated capital of centuries of growth has been cut--most of it without consideration of conditions necessary to produce a new crop of timber.

Figure 12.- In northwestern California, timber frequently grows on ranch and farm holdings intermingled with natural grassland areas.

Past cutting has given ranchers few economic guides because logging of Douglas-fir timber on ranch and farm holdings is of comparatively recent origin. Consequently, in few cutover areas has young-growth Douglas-fir attained sufficient size and age to enable foresters to determine readily the economic benefits from regeneration of Douglas-fir timber on ranch holdings.

Furthermore, because until comparatively recent times local Douglas-fir was considered of little commercial value, no serious effort was made by ranchers to reestablish new stands of timber. Some let their cutover timberland regenerate naturally to any kind of forest cover. Sometimes this treatment produced valuable stands of young-growth Douglas-fir; at other times, it resulted in heavy stands of hardwood and shrubs of little or no value.

Because of the high stumpage prices of the last 10 or 15 years, landowners are now beginning to seek advice on how best to handle their timberland. The people in Humboldt County, for example, have hired a county forester to study their local timber problems and advise landowners on timber management. Others have sought advice from extension specialists, state and federal foresters, and consulting agencies. These activities have promoted better forestry on some holdings, but there is still much to be done in terms of research, education, and management.

Factors that Influence Regeneration of Douglas-fir Timber on Ranch Holdings in Northwestern California

Timberland owners who contemplate regeneration of timber on their cutover lands should realize that it is seldom possible to reproduce a merchantable stand of commercial timber without some effort and expense. Natural regeneration alone cannot always be relied upon to produce merchantable stands of Douglas-fir timber. Nor can it be assumed that because natural regeneration involves little initial expense by the owner, it is the most economical way to earn the maximum net return from the land.

Redwood can be reestablished by natural means with a minimum of cost because it sprouts from the stump. Slash disposal and adequate protection from fire are the major management items in regenerating redwood stands. In certain areas where the old-growth stands were not well stocked originally, some interplanting may also be necessary to develop a well-stocked commercial stand. But redwood is not as prominent in clearing operations as Douglas-fir because ranch properties usually

contain a much larger acreage of Douglas-fir timberland. Re-establishment of Douglas-fir is the chief problem on most ranches.

Apparently, from the limited amount of technical data now available and from observations in the field, most Douglas-fir regeneration in northwestern California requires a planting program to assure a full stand of Douglas-fir timber within a reasonable time. "Because the cost of planting always appears as a cash expense whereas most of the costs of natural regeneration do not, it may seem that the former is more costly than the latter. Evaluation of the real economic costs of natural regeneration shows, however, that as stumpage values have risen this method has become increasingly less efficient when compared with artificial methods." (15, pp. 6, 7.)

Foresters who have examined and studied cutover timberland areas here have discovered several major factors that influence natural reproduction of Douglas-fir timber. One of these factors, which is common also in other timber-producing areas, is the so-called "hardwood problem."

In many sections of northwestern California, Douglas-fir forests have an understory of hardwood vegetation, chiefly tanoak and Pacific madrone. Although these hardwoods may have commercial value some day, they are now considered unmerchantable timber species which compete with the more valuable Douglas-fir and other desirable commercial conifers. Competition is especially keen after a timber area has been logged. Hardwood trees sprout quickly after the logging operations and capture ground which otherwise would grow conifers. They compete with conifers and may suppress them, and their leaves often smother young conifer seedlings and transplants (10, p.1). Several shrub species and herbaceous plants also compete with the conifers on cutover areas.

Under favorable conditions, conifer species may eventually work through the hardwood and shrub cover and reestablish a conifer stand. This natural process, however, may take a very long time. The costs of carrying land for such a long period may actually exceed the costs of controlling the hardwoods and planting a conifer stand shortly after the old-growth timber is logged.

This obstacle to natural reestablishment of Douglas-fir timber on cutover lands in northwestern California is a serious one, and foresters usually recognize the need to find ways of utilizing and controlling hardwood growth economically.

Figure 13.- Hardwood and brush sprouts grow very rapidly after the timber has been logged.

The scarcity of good seed crops with which to restock cutover lands adequately also influences natural regeneration adversely. In many years, Douglas-fir trees in northwestern California produce only a small fraction of the number of seeds required for satisfactory natural regeneration, and many of these seeds (as much as three-fourths) are often of poor quality.[5/] Every few years a good seed crop will occur, but no method has been developed for predicting these good years.

Insect damage to Douglas-fir cones and seeds is associated with unsatisfactory natural seed supplies. In a survey made in 1954, it was discovered that as much as four-fifths of the Douglas-fir yearly seed crop had been destroyed by insects. "Lack of satisfactory regeneration has frequently been observed in Douglas-fir....cutting areas despite an abundant crop of cones. Occasionally, lack of seed during a good cone-crop year

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5/ Roy, D. F. Forest Management Research in the North Coast Range Problem Area. Calif. Forest and Range Expt. Sta. Berkeley. 5 pp. Feb. 28, 1957. (Manuscript report.)

may be caused by adverse weather conditions, such as freezing temperatures in the early stages of cone development. But generally speaking the failure of a cone to produce sound seeds can be directly traced to insects. The insects may cause failure of a seed crop by eating the seeds or by destroying the flowers of immature cones" (5, p. 1).

The browsing of seedlings and young trees by deer and domestic livestock is destructive to reproduction and growth of Douglas-fir timber in this area. Many areas were observed in which young Douglas-fir trees were heavily browsed. Although some of these trees were 8 or more years old, they were dwarfed and badly deformed. Some of them will eventually develop a leader above the reach of the animals, but the potential growth lost while the new leader develops represents a financial loss to the landowner. Browsing of young trees by deer and livestock is so common in this area that it is questionable whether even planted trees could do well here unless given adequate protection.

Damage by livestock can be prevented by eliminating grazing during the early years of tree growth. Browsing by deer is difficult to control. Fences have been designed to keep deer out of timber areas, but their construction and maintenance requires a good deal of labor and expense (2). Reduction of the deer population by heavy hunting in the vicinity of newly established forest stands may be necessary to assure successful development of trees.

Variations in weather also affect reestablishment of Douglas-fir timber stands on cutover land in this area. In some years, weather and other natural conditions are "just right" to establish dense stands of young trees. But in many years, rainfall, temperatures, and other climatic conditions prevent or retard germination and growth of young seedlings. Hardening of the soil during the years after logging reduces effectiveness of the seedbed and may prevent natural reproduction even during good seed years. Also, as time after logging increases, the cutover land becomes a better habitat for seed-eating rodents. Examination of several recently logged areas showed marked variability in the reproduction of young Douglas-fir stands. Some areas had dense stands of thrifty young trees, others were almost treeless. An owner of cutover timberland may have to wait for that "perfect year" to reestablish a suitable young-growth stand by natural regeneration, and the wait may sometimes be too long for maximum income.

These obstacles are mentioned here to alert owners of timberland to the fact that unplanned natural regeneration is subject to considerable risk and cannot always be relied upon to produce a commercial stand of timber. Even if a satisfactory commercial stand should eventually result from unplanned natural regeneration, it still may not be the most economical way to get it.

Figure 14.- Browsing of young Douglas-fir trees by deer and domestic livestock results in deformed trees like these.

Establishing a Productive Timber Stand

In 1951, timber-management specialists of the Forest Service began a study in the North Coast Douglas-fir forest to develop effective methods for regenerating Douglas-fir timber in this area. Preliminary information from this study suggests that relatively small cutover areas are best for forest regeneration (14, p. 16). Technicians engaged in the study have found that clear-cut areas of from 10 to 20 acres (averaging about 15 acres) provide reasonably high probability for successful natural regeneration. The clear-cuttings should be 300 to 600 feet wide and surrounded by a suitable seed source. Larger clear-cut areas are not recommended unless the owner intends to plant young trees immediately because the effectiveness of Douglas-fir seed dispersal in this area is limited to about 300 to 400 feet from the source of seed.

An owner with a large acreage of timber can checkerboard his holding with small clear-cut areas. As these become stocked, adjoining blocks can be cut. Cutting of the last old-growth stands would be delayed until the young timber reached seed-bearing size; if old growth is cut earlier, the areas could be planted.

Selective cutting of Douglas-fir timber in this area is not recommended for several reasons:

(1) Usually, there is not sufficient difference in age of the individual trees within the timber stands.

(2) Residual trees become subject to windthrow and sunscald when the surrounding trees are removed.

(3) Some residual trees are damaged during the logging operations and may die eventually.

(4) Some trees, although small, are really old and diseased and will not produce timber of much value.

(5) Repeated logging operations seriously disturb or damage many of the seedlings and young trees which grow after the initial logging.

(6) Seed trees left in a cutover area represent timber values that may well be applied more profitably to planting costs.

After a timber area has been logged, silvicultural specialists suggest that heavy accumulations of slash be removed whether

the cutover area is to be planted or allowed to restock by natural means. Removal of slash will reduce the fire hazard and provide a better seedbed. To give natural regeneration a chance, the owner may wait about 3 years after logging and slash disposal. Then, if a satisfactory crop of seedlings has not developed, it is suggested that trees be planted to avoid serious competition from hardwoods and brush sprouts (11). Interplanting may be necessary in cutover areas where partial stocking has occurred, especially in the center of the areas, where fewer seeds fall.

Logging in small patches as suggested here permits the owner of a large tract of old-growth timber to extend the harvesting of his timber over a long time if he wishes. This can be done so as to provide him with a series of annual or periodic income payments which, if properly spaced, can be continued indefinitely as the cutover blocks are restocked.

Costs of Reestablishing a Timber Stand

To the owner of the land, the costs of producing timber... "consist of the original outlay for land, trees and planting. Every year he will have extra expenses for taxes, fire protection, and forest labor. His total costs will consist of all the actual outlays with compound interest up to the time of his harvest. This method is justified since he might have taken the alternative opportunity of placing his money in a bank and reinvesting his annual interest.... However, he is justified in taking only a low rate of interest according to the opinion of forest economists" (3, p. 285). There is, however, no practical reason why forestry should pay less for investment capital than any other industry. An investor contemplating going into timber production for profit should bear this in mind and consider other alternative forms of investment which might pay higher rates of interest.

Costs of reestablishing a productive commercial stand of timber vary considerably, depending upon topography, amount of slash remaining on the ground after logging, weather, and other factors that affect timber growth. If a landowner is lucky enough to hit that "perfect year" during the 3-year waiting period after logging, he can reestablish his timber stand at minimum cost. But if conditions are such that he must plant all his cutovers artificially with little or no help from nature, his costs will run high.

What it may cost to reestablish a timber stand can be judged from tables 3 and 4. These tables were prepared from figures representing average costs of planting Douglas-fir in National Forest areas in northwestern California[6/] and from other sources. Although the figures are subject to modification in line with local conditions, they do provide a guide as to what a landowner might need to spend (in money, effort, or time) to assure himself a well-stocked stand of young-growth Douglas-fir on his cutover land. By doing much of the work himself and by employing members of his family, he can reduce the cash outlay considerably. From an economic standpoint, however, this study charges the time of the owner and his family at standard rates of pay, on the assumption that they could earn as much elsewhere if they wish.

Tables 3 and 4 were set up at three different levels to accommodate low-, medium-, and high-cost areas. Each column was broken down into the several steps usually performed in planting operations. A given owner could pay high costs for some steps, low costs for others. By using appropriate values from the various columns, it is possible to obtain many more combinations than those shown in these tables.

The last three columns show what money spent today will amount to in 70 years at interest rates of 3 or 4 percent. A 70-year period was selected because this is a reasonable rotation age for the timber; yearly growth of Douglas-fir ordinarily starts to decline appreciably after 70 years (table 10), and the timber is considered ready for harvest as sawlogs. Comparison of the accumulated costs in 70 years with the expected value of 70-year-old standing timber will give the owner some indication of the profitableness of his investment.

If an owner strikes a good year for natural regeneration and does not have to plant, the cost of the new stand is limited to interest on the value of the land, cost of slash removal plus interest on this cost, and taxes plus interest on taxes paid. If his situation were about average (medium-cost level) then cost of his timber at 70 years would amount to a little more than $200 per acre at an interest rate of 3 percent, and $384 at 4 percent.

High planting costs plus high taxes and other carrying charges could run his total up to $800 at 3 percent interest, or more than $1,500 at 4 percent.

6/ Data on costs of planting from files of D. F. Roy, Division of Forest Management Research, Calif. Forest and Range Expt. Sta. Berkeley. 1957.

Table 3.- Cost per acre of establishing a stand of Douglas-fir with interest at 3 percent for 70 years

Item	Cost per acre			Value of interest factor	Accumulated cost per acre at age 70		
	Low	Medium	High		Low	Medium	High
	Dollars				Dollars		
Restocking costs:							
Slash removal	5.00	10.00	15.00	1/ 7.918	39.59	79.18	118.77
Planting stock	6.00	9.00	12.00	7.918	47.51	71.26	95.02
Planting	20.00	30.00	40.00	7.918	158.36	237.54	316.72
Total	31.00	49.00	67.00	--	245.46	387.98	530.51
Annual costs:							
Taxes	.15	.20	.25	2/ 230.594	34.59	46.12	57.65
Administration, etc.	.20	.30	.40	230.594	46.12	69.18	92.24
Total	--	--	--	--	326.17	503.28	680.40
Value of land	5.00	10.00	15.00	7.918	39.59	79.18	118.77
Total costs	--	--	--	--	365.76	582.46	799.17

1/ Figure which $1 will amount to in 70 years at 3 percent interest by applying the formula $s = (1 + i)^n$.

2/ Figure which $1 deposited annually will amount to in 70 years at 3 percent interest by applying the formula

$$\frac{s}{n/} = \frac{(1 + i)^n - 1}{i}$$

Table 4.- Cost per acre of establishing a stand of Douglas-fir, with interest at 4 percent for 70 years

Item	Cost per acre			Value of interest factor	Accumulated cost per acre at age 70		
	Low	Medium	High		Low	Medium	High
	------ Dollars ------				------ Dollars ------		
Restocking costs:							
Slash removal	5.00	10.00	15.00	1/ 15.572	77.86	155.72	233.58
Planting stock	6.00	9.00	12.00	15.572	93.43	140.15	186.86
Planting	20.00	30.00	40.00	15.572	311.44	467.16	622.88
Total	31.00	49.00	67.00	--	482.73	763.03	1,043.32
Annual costs:							
Taxes	.15	.20	.25	2/ 364.290	54.64	72.86	91.07
Administration, etc.	.20	.30	.40	364.290	72.86	109.29	145.72
Total	--	--	--	--	610.23	945.18	1,280.11
Value of land	5.00	10.00	15.00	15.572	77.86	155.72	233.58
Total costs	--	--	--	--	688.09	1,100.90	1,513.69

1/ Figure which $1 will amount to in 70 years at 4 percent interest by applying the formula $s = (1 + i)^n$.

2/ Figure which $1 deposited annually will amount to in 70 years at 4 percent interest by applying the formula

$$\frac{s}{n/} = \frac{(1 + i) - 1}{i}$$

For practical purposes, it can be assumed that most situations will fall somewhere between the low- and medium-cost levels. Initial costs will range from about $35 to $60 per acre plus about $0.50 yearly for taxes, administration, risk, and other incidental charges. Computed at 3 percent interest, these accumulated costs would range from $365 to $582; at 4 percent interest, they would range from $688 to $1,100 per acre.

To keep the cost computations relatively simple, no allowance was made for the cost of thinning or pruning stands during their development. It is assumed that these practices will pay their way in increased production or value and will not be a direct cost against the stands.

Estimated Yield from Restocked Douglas-fir Timberland

"Various combinations of the physical characteristics of forest areas, such as soil, drainage, rainfall, temperature, altitude, slope, and aspect, result in different degrees of favorableness for tree growth. The combined effect of these characteristics on the stand is embraced in the term 'site' or 'site quality.' Between the best and the poorest sites in the Douglas-fir region is a range in productivity, as measured in cubic feet of wood produced, of over 250 percent." (6, p. 8)

Forest land is separated into productivity classes (sites) on the basis of the average total height the dominant trees will attain at 100 years of age. From numerous observations of these physical characteristics, forestry technicians have computed yield tables for Douglas-fir timber which show the volume per acre in fully stocked stands at stated ages by any one of several standards of measure. Average yields of fully stocked stands by age class have been assigned to the various timber-site classes. These average yields can be used as measures of productivity of land for growing timber. Yield tables have not been prepared specifically for the Douglas-fir stands in northwestern California, but well-established tables are available for similar sites in Oregon and Washington. These tables have been used to estimate the future volumes that can be expected of Douglas-fir timber in northwestern California.

As timberland of site classes II and III is most commonly used by ranchers for converting from timber to grass cover, timber yields of land in these two site classes were used as the basis for estimating returns from Douglas-fir timber production. Timber yields and returns on site I lands will be greater than on site II. On the poorer site IV and site V lands, yields will be smaller than on site III lands.

Site classes II and III have been divided into three indices representing the range of tree heights found within each class. These indices are shown in table 5.

Table 5.- Estimated returns per acre from Douglas-fir timber on site classes II and III[1/] managed on an even-aged basis on a rotation of 70 years

Site index	Yield per acre	Value per acre-- at $12 per M	at $16 per M	at $20 per M
	Board-feet[3/]	---------- Dollars ----------		
On site class II:				
Site index 160[2/]	50,000	600.00	800.00	1,000.00
Site index 170	57,200	686.40	915.20	1,144.00
Site index 180	64,600	775.20	1,033.60	1,292.00
On site class III:				
Site index 130[2/]	27,900	334.80	446.40	558.00
Site index 140	35,200	422.40	563.20	704.00
Site index 150	42,500	510.00	680.00	850.00

1/ From McArdle, Richard E. and W. H. Meyer. The Yield of Douglas Fir in the Pacific Northwest. U. S. Dept. Agr. Tech. Bul. 201, p. 27. Washington, D. C. October 1930.

2/ The average height of dominant trees at 100 years of age.

3/ Scribner log rule.

In estimating future returns, stumpage values were set at three levels: $12, $16, and $20 per 1,000 board-feet. Although 1957 stumpage prices averaged near the lower limit of $12, it was assumed that future prices would probably follow past trends and continue upward to $16 or $20 in the 70 years the timber stand requires to reach maturity. These estimates of future stumpage prices may prove to be very conservative.

In other timber areas, the value of young-growth timber has increased rapidly as old-growth became scarce. For example, young-growth stumpage in the South sold in 1957 for $25-45 per 1,000 board-feet. Also, no allowance has been made for sale of

thinnings for pulpwood. The prospects for development of a substantial pulp industry in northwestern California promise a strong pulpwood market in future years.

An owner of well-stocked timberland in the medium range of site II can expect a yield of 57,200 board-feet per acre in 70 years (table 5). Assuming an average price at that time of $16 per 1,000 board-feet, his land would give him a gross income of $915 per acre. At this price, he could afford to spend, at 3 percent interest, $82 per acre for land purchase and planting costs, and $0.65 annually for taxes and other incidental costs. This investment would yield him 3 percent interest plus $116 per acre, assuming only a small annual charge for risk or insurance (table 3).7/

If stumpage prices were $20 per 1,000 board-feet, the landowner could expect about $1,144 gross income per acre. An $82-investment for land purchase and planting costs plus $0.65 annually for taxes and other costs would yield the landowner $345 per acre over and above his 3 percent interest. To get 4 percent interest, however, his land-purchase and planting costs per acre could amount to only $59, and taxes and other yearly costs to $0.50 (table 4).

On site III land, the owner has a narrower margin to work with. Site III land of average quality will yield approximately 35,200 board-feet of Douglas-fir timber per acre in 70 years. At $16 per 1,000 board-feet, this land will give the

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7/ Risk is recognized as a significant factor in both timber production and grazing, but its inclusion in our calculations would complicate further an already difficult technical problem. Fire insurance is now available to timber growers. Insurance rates provide a rough measure of risk. For example, the fire insurance rate on timber in 1955 was $5 per $1,000 value per year. The insurance cost is small at the beginning of the growing period when the trees are small and increases gradually each year as the trees get older and larger. This factor adds to the problem of computing reliable figures in comparative analyses of this kind. Timber production is probably more susceptible to risk than grazing because of the long time it takes a stand of timber to mature. For this reason, the item "administration, etc." in tables 3 and 4 contain a small yearly allowance for risk or insurance. To simplify our problem, it is assumed that any risk cost beyond that amount will affect about equally either timber production or grazing and its omission will not seriously affect the general relationship between incomes of the two uses studied here.

owner a gross return of about $563. At this price the owner of the land would fall $19 per acre short of earning 3 percent on his money if he had spent $59 for land and planting costs and $0.50 yearly for taxes and other items.

If he expected a 4 percent return on his investment, he could spend at most $36 for land and planting costs, and afford only $0.35 yearly charges for taxes and other items. He would need to sell his timber near the top price of $20 per 1,000 board-feet when it reached the age of 70.

These estimates of costs and returns show that timber production can be profitable on the better sites even when reproduction must be obtained by tree planting. The margin of profit decreases on the poorer sites and may be negative on some areas.

TIMBER VS. GRASS--WHICH YIELDS MOST?

Production of grass on cutover land differs from timber production in two major ways. In the first place, timber site class has little effect on yield of grass. In fact, site III timberland and certain site IV areas are probably better suited to grazing than timberland of higher sites. Low-site areas usually support less woody vegetation to compete with the grass cover. Also, the clearing job on the low sites usually is less costly and results in a cleaner clearing with a heavier grass cover.

But timber site class affects the yield of timber a good deal. For instance, timberland of site class II yields about 60 percent more timber volume in 70 years than does timberland of site III (table 10). As ranch holdings contain sizable areas of site II, ranchers should evaluate carefully the advisability of clearing this land for grazing. The chances are good that it will yield a greater net return to the owner if left in timber.

The second major difference between grass and timber production is that grass is harvested yearly but that ordinarily timber is harvested after it has grown long enough to produce a fairly large volume of good-quality merchantable timber. Comparison of returns from timber production and grazing necessitates the placement of yields from both on a somewhat comparable basis. From studying yield tables for Douglas-fir, we concluded that it takes about 70 years to grow a merchantable stand of commercial sawtimber. The volume and value of timber when it is growing vary considerably from decade to decade (table 10). When the trees are small, they produce little volume

and the timber has only limited value. As the trees grow older, the yearly income increases materially and the timber gains in quality and value. But timberland that has been converted successfully to range for 10 or more years yields a fairly uniform average forage crop each year for a period of years.

In comparing incomes from grass or timber grown on the same kind of land, land economists usually use one of two methods. One method is to estimate the average yearly net return from grazing, accumulate these yearly incomes with interest for a 70-year period, then compare this figure with the estimated returns from timber at age 70. Another way is to convert the net income realized from the 70-year-old timber into an annual figure comparable to the yearly net income from grass. Both methods are used in the examples that follow. Income relationships between timber and grass are the same by either method.

Accumulated Returns

Tables 6 and 7 show average grazing values for cleared cutover timberland with grazing capacities ranging from 9 to 25 acres per animal-unit year accumulated for a 70-year period with interest at 3 and 4 percent. Rental values on converted land were obtained from table 2 after the yearly taxes and maintenance costs had been deducted from the gross value of the grazing produced. Value of grazing was assumed at an average price of $3 per animal-unit month. (Appendix tables 14, 15, 16, and 17 were compiled to show what the income from grazing accumulated over a 70-year period would be if grazing values of $2 or $4 per animal-unit month were used instead of $3.)

Data for tables 6 and 7 were obtained largely from ranch records and from range specialists familiar with range conditions and practices in the area of study. The average grazing capacity of converted timberland was estimated at about 17 acres per animal-unit year (table 2). To allow for differences in yield due to variations in present or future management of converted timberlands, a range of 9 to 25 acres per animal-unit year is shown in the tables. The median of 17 acres, however, is taken as the average grazing capacity for comparative purposes in our illustrations. This type of rangeland will produce forage crops with an estimated per acre value of $1.42 per year to the rancher who can use the crop advantageously.

Because grass provides a yearly income to the owner of the land, interest on the conversion cost can be paid each year out of the income from grazing. At 3 percent, interest will amount to $0.78 per acre per year. So that grazing income can be compared with returns from timber production, it is also necessary to repay the $26 conversion cost.

Table 6.- Estimated returns per acre at $3 per animal-unit month from forage produced on timberland converted to grassland, 70-year period, interest at 3 percent

Acres per animal-unit year	Rental value of converted land	Interest on clearing costs	Yearly payment to amortize $26 clearing costs	Net yearly return	Value of interest factor	Accumulated net income from land
	Dollars	Dollars	Dollars	Dollars		Dollars
9	3.30	0.78	0.11	2.41	230.594	556
13	2.07	0.78	0.11	1.18	230.594	272
17	1.42	0.78	0.11	0.53	230.594	122
21	1.01	0.78	0.11	0.12	230.594	28
25	0.74	0.78	0.11	--	--	--

Table 7.- Estimated returns per acre at $3 per animal-unit month from forage produced on timberland converted to grassland, 70-year period, interest at 4 percent

Acres per animal-unit year	Rental value of converted land	Interest on clearing costs	Yearly payment to amortize $26 clearing costs	Net yearly return	Value of interest factor	Accumulated net income from land
	Dollars	Dollars	Dollars	Dollars		Dollars
9	3.30	1.04	0.07	2.19	364.290	798
13	2.07	1.04	0.07	0.96	364.290	350
17	1.42	1.04	0.07	0.31	364.290	113
21	1.01	1.04	0.07	--	--	--
25	0.74	1.04	0.07	--	--	--

This expense is necessary in producing grass; it is somewhat comparable to the clearing and planting costs necessary in producing timber. Conversion costs can be repaid in either of two ways. They can be deducted from the accumulated grazing income as a $26 lump sum at the end of the 70-year period. Or, to provide a more realistic figure of yearly net income, a small amount set aside each year with accumulated interest will amortize the $26 conversion cost in 70 years. At 3 percent interest, this will amount to $0.11 per year. Deducting these charges from the $1.42 yearly income from grazing leaves a return to the cutover land of $0.53 per acre (table 6).

If this $0.53 yearly income from the cutover land is deposited in a bank each year at 3 percent interest, it will amount to $122 in 70 years. Thus, $122 is the net return over the 70-year period to the rancher's original cutover land.

In timber production, site II cutover land, fully restocked and kept in timber for 70 years, will yield an estimated gross return of $915 (table 5). This assumes that the timber can be sold for an average price of $16 per 1,000 board-feet. The cost of reestablishing the timber stand averages $49 plus $0.50 yearly for taxes and other costs (table 3). As we are comparing returns to land from grazing and from timber production, the cost of the cutover timberland is omitted from these calculations.

At the end of 70 years, the $49 cost of reestablishing the timber stand and the $0.50 yearly costs with interest at 3 percent will amount to $503. This figure is an investment in the 70-year-old timber stand by the landowner; it is deductible from the $915 estimated gross sale value of the timber. The net return to the cutover land from timber production is $412 per acre.

Site II timberland, then, will eventually yield $290 more per acre from timber production than the yearly grazing values of the cleared cutover land accumulated for 70 years at 3 percent interest (table 8).

On site III land, timber yield drops considerably below that on site II land, but production of grass remains about the same. If a comparable clearing and seeding job has been done, this land should yield about the same grazing value as the site II land--$122 per acre in 70 years. Restocked with Douglas-fir and kept in timber production for 70 years, site III land will yield a return of $563, assuming again that the timber can be sold for an average price of $16 per 1,000 board-feet. If planting costs, taxes, and other yearly charges are about the

Table 8.- Net return to land from $26 spent on an acre of cutover land for clearing and seeding or from $49 spent for restocking to Douglas-fir, in 70 years at 3 percent interest

Site class	Timber			Grass		Difference between timber and grazing income	
	Gross income	Planting and other costs	Net income	Yearly net income	Accumulated net income	Timber	Grass
	Dollars						
Site II land	915	503	412	0.53	122	290	--
Site III land	563	503	60	0.53	122	--	62

Table 9.- Yearly net return to land from $26 spent on an acre of cutover land for clearing and seeding or from $49 spent for restocking to Douglas-fir, interest at 3 percent

Site class	Timber		Grass	Difference between timber and grazing income	
	Net income in 70 years	Equivalent yearly net income	Yearly net income	Timber	Grass
	Dollars				
Site II land	412	1.79	0.53	1.26	--
Site III land	60	0.26	0.53	--	0.27

same as for the site II land, the average net return to the cutover land from timber growth will be $60 per acre. In this case, production of grass will yield the owner of the site III land $62 more per acre than timber production--roughly about twice as much as the timber.

Yearly Income

If timber and grass are compared on an annual basis, the net income from 70-year-old timber must be expressed as an annual figure comparable to the net annual income from grazing. This is done by determining the annuity figure which if deposited annually at compound interest will amount to the net value of the timber at age 70.

On site II land, the net income per acre from a 70-year-old stand of timber was estimated at $412. The equivalent yearly value of this net income is $1.79 per acre. This does not imply that a rancher can actually sell a yearly crop of timber each year for $1.79 if he restocks his land with timber. It does, however, provide an estimate of the amount that his restocked timberland will earn each year if he holds the timber for a 70-year period and then sells it for $412. This equivalent yearly income from timber on site II land will yield $1.26 more per acre than grazing (table 9).

On site III land, equivalent yearly income from timber drops to $0.26--$0.27 less than the estimated yearly income from grazing. Thus, on site III land, net income from grass computed on a yearly basis is still roughly about twice as much as net income from timber.

To Sum Up

These are but examples of methods that a rancher might use to arrive at a reasonable estimate as to whether it is more profitable for him to clear his cutover land for grazing or to restock it in timber. He can appraise the physical characteristics of his land, estimate his costs for land preparation, then use the figures shown here that most closely approximate his situation. Or, if he prefers, he can substitute his own figures and use interest and other factors similar to those shown in these examples.

Actual cases will have too many variables to illustrate here. Quality of land, aspect, condition of plant cover, steepness of terrain, climatic conditions, availability and cost of labor and equipment, market values of forage crops and timber, interest rates, and hazards of establishing and maintaining a

timber or grass cover--these are only a few of the many factors that affect the profitability of different types of use on the same land.

In time preference calculations like those used in comparing costs and returns from timber and grazing, the interest rate is especially important. For example, a 3 percent interest rate will show a net return from timber production on all sites except site IV, but higher rates of interest will show net returns on only the very best timber sites.

Because of the long-term nature of investments in timber production, economists generally concede that low rates of interest (such as the 3 and 4 percent rates used in our examples) are justified in calculating probable future returns from money invested in timberland and in other costs of timber production.

Because grass is a yearly crop, income from grazing is relatively more favorable at high rates of interest than timber production. But grazing will yield little more than 5 percent on money invested in land, land clearing, and other costs of production.

Investors who contemplate going into the business of timber production should realize that money placed in land, planting costs, and management is a long-term investment, which will not yield a high rate of interest during the time it takes the timber to mature.

For the <u>average</u> situation typical of northwestern California, our analysis of all basic facts presented here and our observations in the field indicate that the following conclusions may apply:

1. On suitable terrain and exposures, the predominant Josephine and Hugo timber soils that once supported stands of Douglas-fir timber and hardwoods can be converted to grassland. To be successful, however, the conversion process requires more than merely cutting, burning, and seeding. It also requires much work and very careful range management over a period of years.

2. These soils will also reproduce valuable stands of commercial timber. But natural regeneration alone cannot always be relied upon to produce merchantable stands of Douglas-fir timber. In most instances, a planting program of some kind is necessary to assure reproduction of a full stand of Douglas-fir timber within a reasonable time.

3. A rancher with good-quality timberland (sites I or II) should consider the economic benefits that can be derived from growing timber before attempting to clear this land for grazing. In the long run, it will yield considerably more in timber than in grass.

4. The breaking point in economic benefits from grass or timber is on site III land. With a southern or western exposure, this land will yield more in grass than in timber. With a northern or eastern exposure, it will probably yield more in timber.

5. Site IV timberland will yield more in grass than in timber provided the land is not so steep as to have an erosion problem when cleared. If this land is rough, stony, and steep, it may not be especially suitable for either grass or timber. Perhaps it should remain unimproved and used principally for wildlife habitat and such timber production as can be obtained naturally without planting.

6. Although ranchers spend an average of about $26 per acre for clearing and seeding cutover timberland for grass, the present economic limit for this investment appears to be about $20. As uncleared cutover timberland has an average value of about $10 per acre,this would place an upper limit on total investment per acre of about $30.

7. Average costs of an adequate restocking of cutover timberland to Douglas-fir amount to about $50 per acre. This is about the maximum that can be spent in restocking site III class timberland. Because of potentially higher yields, more can be spent on sites II and I land.

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Table 10.- Yields for Douglas-fir on a fully stocked acre, trees 12 inches in diameter and larger on site classes I, II, III, and IV[1]

Age	Site class IV Site index 110[2]		Site class III Site index 140[2]		Site class II Site Index 170[2]		Site class I Side index 200[2]	
	Total yield	Yield each 10-year period	Total yield	Yield each 10-year period	Total yield	Yield each 10-year period	Total yield	Yield each 10-year period
Years	Board feet[3]							
30	0	-	300	-	2,600	-	8,000	-
40	200	-	4,500	4,200	11,900	9,300	24,400	16,400
50	3,300	3,100	12,400	7,900	27,400	15,500	44,100	19,700
60	8,100	4,800	23,800	11,400	42,800	15,400	62,000	17,900
70	14,000	5,900	35,200	11,400	57,200	14,400	78,200	16,200
80	20,100	6,100	45,700	10,500	70,000	12,800	92,500	14,300
90	26,000	5,900	55,000	9,300	81,000	11,000	104,800	12,300
100	31,400	5,400	62,800	7,800	90,400	9,400	115,100	10,300

1/ From McArdle, Richard E. and W. H. Meyer. The Yield of Douglas-fir in the Pacific Northwest. U. S. Dept. Agr. Tech. Bul. 201, p. 27. Washington, D. C. October 1930.

2/ The total height that the dominant trees reach at 100 years of age.

3/ Scribner log rule.

Table 11.- Estimated returns per acre from Douglas-fir timber on site classes I and IV[1/] managed on an even-aged basis on a rotation of 70 years

Site index[2/]	Yield per acre	Value per acre		
		At $12 per M	At $16 per M	At $20 per M
	Board feet[3/]	Dollars	Dollars	Dollars
On site class I:				
Site index 190	71,500	858.00	1,144.00	1.430.00
Site index 200	78,200	938.40	1,251.20	1,564.00
Site index 210	85,000	1,020.00	1,360.00	1,700.00
On site class IV:				
Site index 100	9,000	108.00	144.00	180.00
Site index 110	14,000	168.00	224.00	280.00
Site index 120	20,600	247.20	329.60	412.00

1/ From McArdle, Richard E. and W. H. Meyer. The Yield of Douglas-fir in the Pacific Northwest. U. S. Dept. Agr. Tech. Bul. 201, p. 27. Washington, D. C. October 1930.

2/ The total height that the dominant trees reach at 100 years of age.

3/ Scribner log rule.

Table 12.- Estimated income from grazing an acre of cutover timberland, assuming an average grazing capacity of 17 acres per animal-unit year, and 3 percent interest on income to land accumulated for 70 years at various clearing costs

Clearing costs	Gross yearly income	Yearly costs[1]	Net yearly income	70-year accumulated income	70-year accumulated net income[2]
		Dollars			
5	2.12	0.85	1.27	293	288
10	2.12	1.00	1.12	258	248
15	2.12	1.15	.97	224	209
20	2.12	1.30	.82	189	169
25	2.12	1.45	.67	154	129
30	2.12	1.60	.52	120	90
35	2.12	1.75	.37	85	50
40	2.12	1.90	.22	51	11
45	2.12	2.05	.07	16	-

1/ Includes: taxes $0.30, maintenance $0.40, and 3 percent interest on clearing costs.

2/ 70-year accumulated income less clearing costs.

Table 13.- Value per acre of various planting and yearly costs of 70-year-old Douglas-fir timber at 3 percent interest

Planting costs	Accumulated planting costs at age 70	Annual costs	Accumulated annual costs at age 70
	Dollars		
10	79	0.10	23
20	158	.20	46
30	238	.30	69
40	317	.40	92
50	396	.50	115
60	475	.60	138
70	554	.70	161
80	633	.80	184
90	713	.90	208
100	792	1.00	231
110	871	1.10	254
120	950	1.20	277
130	1,029	1.30	300
140	1,109	1.40	323
150	1,188	1.50	346

Table 14.- Estimated returns per acre at $4 per animal-unit month from forage produced on timberland converted to grassland, 70-year period, with interest at 3 percent

Acres per animal-unit year	Rental value of converted land	Interest on clearing costs	Yearly payment to amortize $26 clearing costs	Net yearly return	Value of interest factor	Accumulated net income from land
	Dollars	Dollars	Dollars	Dollars		Dollars
9	4.63	0.78	0.11	3.74	230.594	862
13	2.99	.78	.11	2.10	230.594	484
17	2.12	.78	.11	1.23	230.594	283
21	1.59	.78	.11	.70	230.594	161
25	1.22	.78	.11	.33	230.594	76

Table 15.- Estimated returns per acre at $4 per animal-unit month from forage produced on timberland converted to grassland, 70-year period, with interest at 4 percent

Acres per animal-unit year	Rental value of converted land	Interest on clearing costs	Yearly payment to amortize $26 clearing costs	Net yearly return	Value of interest factor	Accumulated net income from land
	Dollars	Dollars	Dollars	Dollars		Dollars
9	4.63	1.04	0.07	3.52	364.290	1,282
13	2.99	1.04	.07	1.88	364.290	685
17	2.12	1.04	.07	1.01	364.290	368
21	1.59	1.04	.07	.48	364.290	175
25	1.22	1.04	.07	.11	364.290	40

Table 16.- Estimated returns per acre at $2 per animal-unit month from forage produced on timberland converted to grassland, 70-year period, with interest at 3 percent

Acres per animal-unit year	Rental value of converted land	Interest on clearing costs	Yearly payment to amortize $26 clearing costs	Net yearly return	Value of interest factor	Accumulated net income from land
	Dollars	Dollars	Dollars	Dollars		Dollars
9	1.97	0.78	0.11	1.08	230.594	249
13	1.15	.78	.11	.26	230.594	60
17	.71	.78	.11	-	-	-
21	.44	.78	.11	-	-	-
25	.26	.78	.11	-	-	-

Table 17.- Estimated returns per acre at $2 per animal-unit month from forage produced on timberland converted to grassland, 70-year period, with interest at 4 percent

Acres per animal-unit year	Rental value of converted land	Interest on clearing costs	Yearly payment to amortize $26 clearing costs	Net yearly return	Value of interest factor	Accumulated net income from land
	Dollars	Dollars	Dollars	Dollars		Dollars
9	1.97	1.04	0.07	0.86	364.290	313
13	1.15	1.04	.07	.04	364.290	15
17	.71	1.04	.07	-	-	-
21	.44	1.04	.07	-	-	-
25	.26	1.04	.07	-	-	-

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